Attachment 1

* NOTICES * Translation of JP 7-154201

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the surface acoustic wave filter used for mobile communication equipment etc., and the surface acoustic wave filter which has the magnitude of attenuation outside high bandwidth especially.
[0002]
[Description of the Prior Art] The demand to the electrical characteristics of a surface acoustic wave filter, formation of small lightweight, etc. which are used as an interstage filter, an antenna filter, etc. of transmission and reception of various mobile communication equipment is becoming still severer with development of mobile communications. Especially the demand to the magnitude of attenuation out of band is severe, and the filter for transmission has come to require the 40-60dB magnitude of attenuation in a receiving band in a transmitting band with the filter for reception. Thus, by realizing the surface acoustic wave filter which has the magnitude of attenuation outside high bandwidth, it is possible to realize the receive section or transmitting section circuit of mobile communication equipment conventionally constituted using two or more filters with one surface acoustic wave filter, and the miniaturization of a device and low cost-ization are attained.
[0003] Below, the conventional surface acoustic wave filter is explained. Drawing 7 and drawing 8 are the plans showing the outline of the conventional surface acoustic wave filter. drawing 7 and drawing 8 -- setting -- 1 -- a piezo electric crystal substrate and 2 -- for an input-electrode pad and 5, as for an earth electrode pad and 7, an output-electrode pad and 6 are [a serial arm surface acoustic wave resonator and 3 / a juxtaposition arm surface acoustic wave resonator and 4 / a serial arm signal line and 8] juxtaposition arm signal lines.
[0004] Cascade connection of two or more serial arm surface acoustic wave resonators 2 and the juxtaposition arm surface acoustic wave resonator 3 was carried out to the ladder mold on the piezo electric crystal substrates 1, such as lithium tantalate and lithium niobate, the surface acoustic wave filter was constituted from a conventional surface acoustic wave filter, and the input-electrode pad 4 and the output-electrode pad 5 were arranged on extension of the serial arm signal line 7. With said conventional configuration, the limitation was in the cascade connection number of stages of a surface acoustic wave resonator from the constraint on the electrode design by the demand to the electrical characteristics constraint of a chip size, an insertion loss, in [VSWR] a band, etc., and about 30dB of the magnitude of attenuation out of band was a limitation.
[0005] Moreover, when the cascade connection number of stages of a surface acoustic wave resonator tended to be made [many] and it was going to secure the large magnitude of attenuation out of band with the same chip size as said conventional surface acoustic wave filter, as shown in drawing 8 , it had become the configuration that a serial arm and the juxtaposition arm surface acoustic wave resonators 2 and 3, the ********** pad 4 and the output-electrode pad 5, a serial arm and the juxtaposition arm signal line 7, and 8 grades adjoined mutually.
[0006]

[Problem(s) to be Solved by the Invention] However, with the configuration which the surface acoustic wave resonator, the input-electrode pad, the output-electrode pad, and the signal line adjoined mutually, in spite of it becoming impossible to have disregarded the level of the direct wave of said **** Rhine or a serial arm signal line to a juxtaposition arm signal line etc. from said input-electrode pad or said output-electrode pad and having made multistage connection of the surface acoustic wave resonator, there was a problem that the magnitude of attenuation out of band was not securable enough.
[0007] This invention solves said conventional trouble, mitigates the level of said direct wave, and aims at securing sufficient magnitude of attenuation out of band.
[0008]
[Means for Solving the Problem] In order to attain said purpose, the surface acoustic wave filter of this invention has the configuration which arranged the earth electrode pattern between said input-electrode pad or said output-electrode pad, and said signal line in the surface acoustic wave filter with which two or more surface acoustic wave resonators were formed on the piezo electric crystal substrate, and the surface acoustic wave filter was constituted by carrying out cascade connection of said surface acoustic wave resonator, and the input-electrode pad of said surface acoustic wave filter or the output-electrode pad, and the signal line approached.
[0009]
[Function] By the configuration of said surface acoustic wave filter, the level of the direct wave between an input-electrode pad or an output-electrode pad, and a signal line is mitigated, while sufficient magnitude of attenuation out of band corresponding to the multistage cascade connection of a surface acoustic wave resonator is securable, components mark, such as mobile communication equipment, are reduced by implementation of a high attenuation surface acoustic wave filter, and miniaturization of a device and low cost-ization are also enabled.
[0010] Moreover, also in the configuration of the conventional surface acoustic wave filter, since a signal line and a surface acoustic wave resonator can be approached and an I/O electrode pad can be arranged, it is also possible to attain the miniaturization of a chip size.
[0011]
[Example] (Example 1) The 1st example of this invention is hereafter explained to a detail, referring to a drawing. Drawing 1 is the plan showing the outline of the configuration of the surface acoustic wave filter in the 1st example of this invention. drawing 1 -- setting -- 1 -- a piezo electric crystal substrate and 2 -- a serial arm surface acoustic wave resonator and 3 -- for an output-electrode pad and 6, as for a serial arm signal line and 8, an earth electrode pad and 7 are [a juxtaposition arm surface acoustic wave resonator and 4 / an input-electrode pad and 5 / a juxtaposition arm signal line and 9] earth electrode patterns.
[0012] In this example, the surface acoustic wave filter of three steps of T molds was formed by making into a base unit what carried out cascade connection of two serial arm resonators 2 and the one juxtaposition arm resonator 3 to T mold, using the lithium tantalate of 36 degreeY cut X propagation as a piezo electric crystal substrate 1. Between the input-electrode pad 4 and the output-electrode pad 5, and signal lines 7 and 8, the earth electrode pattern 9 is formed as a screening electrode, and it connected with the earth electrode pad 6 and the earth terminal similarly formed in the package of the bonding wire. In this example, the aluminum thin film was used as an electrode material. The frequency characteristics of the surface acoustic wave filter of three steps of T molds according the frequency characteristics of the surface acoustic wave filter by this example to the conventional configuration are shown in drawing 2 (a) at drawing 2 (b). The surface acoustic wave filter by this example was a filter for reception for cellular phones whose center frequency is 872.5MHz, and the thing of the isolation of the ceramic package (3.8mmx3.8mmx1.5mm) which the magnitude of attenuation in the area outside a high-frequency marginal strip (transmitting band) had secured 60dB, and was used by this example mostly oppressed to a limitation was possible. Although the magnitude of attenuation in the stop band by the side of high frequency was almost equivalent to the case of this example, the magnitude of attenuation is small and was not able to fill demand characteristics with the case of the surface acoustic wave filter of the conventional configuration as the frequency became high. thus, when realizing the

about 40-60dB magnitude of attenuation with said conventional configuration, it becomes impossible to disregard the level of a direct wave, and the magnitude of attenuation which saw and was in the connection number of stages of a surface acoustic wave resonator cannot be secured.
[0013] In addition, although the lithium tantalate of 36 degreeY cut X propagation was used as a piezo electric crystal substrate 1 in this example, it is clear that the same effectiveness is acquired also in the case of the substrate using other piezo electric crystal substrates or piezo electric crystal thin films.
[0014] as mentioned above, in the surface acoustic wave filter with which two or more surface acoustic wave resonators were formed on the piezo electric crystal substrate, and the surface acoustic wave filter was constituted by carrying out cascade connection of said surface acoustic wave resonator, and the input-electrode pad of said surface acoustic wave filter or the output-electrode pad, and the signal line approached, sufficient magnitude of attenuation out of band which saw and was in the cascade connection number of stages of a surface acoustic wave resonator is securable with the configuration which arranged the earth electrode pattern between said input-electrode pad or said output-electrode pad, and said signal line.
[0015] (Example 2) The 2nd example of this invention is hereafter explained to a detail, referring to a drawing. Drawing 3 is the plan showing the outline of the configuration of the surface acoustic wave filter in the 2nd example of this invention. drawing 3 -- setting -- 1 -- a piezo electric crystal substrate and 2 -- a serial arm surface acoustic wave resonator and 3 -- for an output-electrode pad and 6, as for a serial arm signal line and 8, an earth electrode pad and 7 are [a juxtaposition arm surface acoustic wave resonator and 4 / an input-electrode pad and 5 / a juxtaposition arm signal line and 9] earth electrode patterns.
[0016] Also in this example, the lithium tantalate of 36 degreeY cut X propagation was used as a piezo electric crystal substrate 1 like the 1st example. As a configuration, the surface acoustic wave filter of two steps of T molds was formed by making into a base unit what carried out cascade connection of two serial arm resonators 2 and the one juxtaposition arm resonator 3 to T mold. Moreover, between the surface acoustic wave resonators 2 connected succeeding the serial arm, the earth electrode pattern 9 is formed as a screening electrode, and it connected with the earth electrode pad 6 and the earth terminal similarly formed in the package of the bonding wire. Moreover, also in this example, the aluminum thin film was used as an electrode material. The level of the direct wave between the surface acoustic wave resonators 2 continuously connected to the serial arm by the configuration of this example could be mitigated, and there was a 1-2dB improvement effect by the magnitude of attenuation out of band compared with the conventional configuration.
[0017] As mentioned above, two or more surface acoustic wave resonators are formed on a piezo electric crystal substrate. In the surface acoustic wave filter which constitutes a surface acoustic wave filter and by which at least two or more surface acoustic wave resonators were continuously connected to the serial arm by carrying out cascade connection of said surface acoustic wave resonator Between said surface acoustic wave resonators continuously connected to the serial arm, by arranging an earth electrode pattern, the direct wave level between series resonance children can be mitigated, and the magnitude of attenuation out of band can be improved. Moreover, distance between the surface acoustic wave resonators continued and connected to the serial arm by said configuration can be made small, and it contributes also to the miniaturization of a chip size.
[0018] (Example 3) The 3rd example of this invention is hereafter explained to a detail, referring to a drawing. Drawing 4 is the plan showing the outline of the configuration of the surface acoustic wave filter in the 3rd example of this invention. drawing 4 -- setting -- 1 -- a piezo electric crystal substrate and 2 -- a serial arm surface acoustic wave resonator and 3 -- for an output-electrode pad and 6, as for a serial arm signal line and 8, an earth electrode pad and 7 are [a juxtaposition arm surface acoustic wave resonator and 4 / an input-electrode pad and 5 / a juxtaposition arm signal line and 9] earth electrode patterns.
[0019] In this example, the surface acoustic wave filter of two steps of T molds was formed like the 2nd example by making into a base unit what carried out cascade connection of two serial arm resonators 2 and the one juxtaposition arm resonator 3 to T mold, using the lithium tantalate of 36 degreeY cut X

propagation as a piezo electric crystal substrate 1. Moreover, between another [which adjoins the juxtaposition arm signal line 8 and it] juxtaposition arm signal lines 8, the earth electrode pattern 9 is formed as a screening electrode, and it connected with the earth electrode pad 6 and the earth terminal similarly formed in the package of the bonding wire. Also in this example, the aluminum thin film was used as an electrode material. It was possible to have been able to mitigate the level of a direct wave mutual [between juxtaposition arm signal lines], and to have improved the magnitude of attenuation out of band by the configuration of this example, compared with the conventional configuration. Moreover, although the earth electrode pattern was arranged only between the juxtaposition arm signal lines 8 in this example, by arranging an earth electrode pattern also between the serial arm signal line 7 and the juxtaposition arm signal line 8, the direct wave level between signal lines can be mitigated, and a still more reliable surface acoustic wave filter can be obtained.

[0020] In addition, although the above showed the surface acoustic wave filter of 2 steps of T mold configuration, it cannot be overemphasized that effectiveness with the same said of the case of the filter of 3 steps of T mold configuration or the usual ladder mold connection is acquired.

[0021] As mentioned above, by forming two or more surface acoustic wave resonators on a piezo electric crystal substrate, and arranging an earth electrode pattern in the surface acoustic wave filter constituted by carrying out cascade connection of said surface acoustic wave resonator between a serial arm signal line and a juxtaposition arm signal line or between a juxtaposition arm signal line, and it and the juxtaposition arm signal line which approached, direct wave level mutual [between a serial arm or juxtaposition arm signal lines] can be mitigated, and the magnitude of attenuation out of band can be improved. Moreover, by said configuration, the distance of a serial arm and a juxtaposition arm signal line can be reduced, and it contributes also to the miniaturization of a chip size.

[0022] (Example 4) The 4th example of this invention is hereafter explained to a detail, referring to a drawing. Drawing 5 is the plan showing the outline of the configuration of the surface acoustic wave filter in the 4th example of this invention. drawing 5 -- setting -- 1 -- a piezo electric crystal substrate and 2 -- a serial arm surface acoustic wave resonator and 3 -- for an output-electrode pad and 6, as for a serial arm signal line and 8, an earth electrode pad and 7 are [a juxtaposition arm surface acoustic wave resonator and 4 / an input-electrode pad and 5 / a juxtaposition arm signal line and 9] earth electrode patterns.

[0023] In this example, the surface acoustic wave filter of three steps of T molds was formed like the 1st example by making into a base unit what carried out cascade connection of two serial arm resonators 2 and the one juxtaposition arm resonator 3 to T mold, using the lithium tantalate of 36 degreeY cut X propagation as a piezo electric crystal substrate 1. Moreover, the serial arm surface acoustic wave resonator 2 and the juxtaposition arm surface acoustic wave resonator 3 connected with the earth terminal which the earth electrode pattern 9 is formed as a screening electrode, and was formed in the part arranged as **** at the propagation direction of a surface acoustic wave, i.e., X shaft orientations of the piezo electric crystal substrate in this example, and parallel of the bonding wire like the earth electrode pad 6 at the package. Also in this example, the aluminum thin film was used as an electrode material. It is possible to be able to prevent unnecessary association of a surface acoustic wave, to improve the magnitude of attenuation out of band compared with the conventional configuration, and to remove unnecessary spurious one by the configuration of this example, while mitigating the level of the mutual direct wave of the serial arm surface acoustic wave resonator 2 and the juxtaposition arm surface acoustic wave resonator 3. a configuration with [to a surface acoustic wave resonator / all] a reflector with the surface acoustic wave filter of this example -- ** -- although it has become, when the resonator which does not have a reflector partially is prepared, said especially configuration is effective in respect of spurious removal. Moreover, according to said configuration, the distance between a serial arm surface acoustic wave resonator and a juxtaposition arm surface acoustic wave resonator can be reduced, and it contributes also to the miniaturization of a chip size.

[0024] As mentioned above, the surface acoustic wave resonator which formed two or more surface acoustic wave resonators on the piezo electric crystal substrate, and constituted the surface acoustic wave filter by carrying out cascade connection of said surface acoustic wave resonator, and was

connected to at least 1 or more sets of serial arms, In the surface acoustic wave filter with which the surface acoustic wave resonator connected to the juxtaposition arm has been arranged as **** at the propagation direction of each surface acoustic wave, and parallel Between the surface acoustic wave resonator connected to said serial arm, and the surface acoustic wave resonator connected to said juxtaposition arm By arranging an earth electrode pattern, the direct wave level between a serial arm surface acoustic wave resonator and a juxtaposition arm surface acoustic wave resonator is mitigated, and while improving the magnitude of attenuation out of band, unnecessary spurious one is mitigable.
[0025] (Example 5) The 5th example of this invention is hereafter explained to a detail. In this example, it has composition which formed thickly [thickness] the surface acoustic wave resonator 2 and 3 grades rather than the conductive film to constitute in the earth electrode pattern 9 of the surface acoustic wave filter shown in the 1st example. The aluminum film of thickness (this example about 4300A) suitable as a concrete process to form the surface acoustic wave resonator 2 and 3 grades first is formed by the spatter. Said surface acoustic wave resonator, earth electrode pattern, etc. are formed by the usual photolithography technique. Next, about 4000A earth electrode pattern was further formed by the lift-off technique using the mask of only an earth electrode pattern. Thus, the earth electrode pattern which has the film twice [about] the thickness of conductive which forms a surface acoustic wave resonator was obtained. By said configuration, while making sheet resistance of an earth electrode pattern small, a shielding effect can be heightened. Moreover, since it becomes possible to reduce the area of an earth electrode pattern, it contributes also to the miniaturization of a chip size.
[0026] As mentioned above, by making it thicker than the thickness of the conductive film which forms the surface acoustic wave resonator, the thickness of an earth electrode pattern can heighten the mitigation effectiveness of direct wave level, and can secure the magnitude of attenuation out of band enough.
[0027] In addition, it does not need to be based on said process shown especially by this example as a process of an earth electrode pattern.
[0028] (Example 6) The 6th example of this invention is hereafter explained to a detail. Rather than the conductive film (aluminum thin film) which constitutes the surface acoustic wave resonator 2 and 3 grades for the earth electrode pattern 9 of the surface acoustic wave filter shown in the 1st example from this example, conductivity was high and gold (about 3000A) was used as a metal with large specific gravity. By said configuration, while heightening a shielding effect, the inhibition effectiveness of unnecessary association between the surface acoustic wave resonators shown in the 4th example can also be heightened.
[0029] In this example, although the golden electrode was used as an earth electrode pattern, even if it uses the alloy which has a gold alloy containing palladium etc., and other high conductivity, it does not interfere.
[0030] As mentioned above, by forming with an ingredient with high conductivity more greatly than the specific gravity of the conductive film with which the specific gravity and conductivity of the conductive film which form the earth electrode pattern form the surface acoustic wave resonator, the mitigation effectiveness of direct wave level can be heightened and the magnitude of attenuation out of band can be secured enough.
[0031] (Example 7) The 7th example of this invention is hereafter explained to a detail. On the earth electrode pattern 9 which consists of aluminum of the surface acoustic wave filter shown in the 1st example, as a substrate metal membrane, 3000A of gold is formed further and 500A has in chromium composition with the earth electrode pattern 9 which consists of three layers in this example. While being able to make sheet resistance of an earth electrode pattern small and heightening a shielding effect by said configuration, the inhibition effectiveness of unnecessary association between the surface acoustic wave resonators shown in the 4th example can also be heightened. Moreover, compared with the case where an example 6 shows, the adhesion force of an earth electrode pattern and a substrate can be heightened, and a reliable surface acoustic wave filter can be obtained.
[0032] In this example, although the golden electrode was used for the maximum upper layer of an earth electrode pattern, even if it uses the conductive ingredient which has a gold alloy containing palladium

etc., and other high conductivity, it does not interfere.
[0033] As mentioned above, by forming an earth electrode pattern with the conductive film which consists of an ingredient with which it differs more than two-layer, the mitigation effectiveness of direct wave level is heightened, and while the magnitude of attenuation out of band is securable enough, a reliable surface acoustic wave filter can be obtained.
[0034] (Example 8) The 8th example of this invention is hereafter explained to a detail, referring to a drawing. Drawing 6 is the plan showing the outline of the configuration of the surface acoustic wave filter in the 8th example of this invention. drawing 6 -- setting -- 1 -- a piezo electric crystal substrate and 2 -- a serial arm surface acoustic wave resonator and 3 -- for an output-electrode pad and 6, as for a serial arm signal line and 8, an earth electrode pad and 7 are [a juxtaposition arm surface acoustic wave resonator and 4 / an input-electrode pad and 5 / a juxtaposition arm signal line and 9] earth electrode patterns.
[0035] In this example, the surface acoustic wave filter of three steps of T molds was formed by making into a base unit what carried out cascade connection of two serial arm resonators 2 and the one juxtaposition arm resonator 3 to T mold, using the lithium tantalate of 36 degreeY cut X propagation as a piezo electric crystal substrate 1. In addition, in this example, the thing of a configuration of not having a reflector was used as a serial arm surface acoustic wave resonator 2. Furthermore, it has the propagation direction of a surface acoustic wave, and the composition of having given the include angle of 45 degrees, in the earth electrode pattern 9 of the surface acoustic wave filter shown in the 4th example. By said configuration, the surface acoustic wave which has leaked from the reflector can be reflected outside, and it can mitigate unnecessary spurious one. It cannot be overemphasized that said configuration is especially effective to the surface acoustic wave filter using the surface acoustic wave resonator which does not have a reflector like this example. Moreover, when thickness of an earth electrode pattern is made thicker than thickness, such as a surface acoustic wave resonator, or it forms by the conductive film which has high specific gravity, such as gold, and high conductivity, much more improvement effect is seen.
[0036] As mentioned above, the side close to the surface acoustic wave resonator of an earth electrode pattern can obtain the propagation direction of a surface acoustic wave, and the surface acoustic wave filter which removed unnecessary spurious one and was excellent in the property by forming so that a fixed include angle may be made.
[0037]
[Effect of the Invention] This invention can obtain sufficient magnitude of attenuation out of band in the surface acoustic wave filter with which two or more surface acoustic wave resonators were formed on the piezo electric crystal substrate, and the surface acoustic wave filter was constituted by carrying out cascade connection of said surface acoustic wave resonator, and the I/O electrode pad and signal line of said surface acoustic wave filter approached by having the configuration which arranged the earth electrode pattern between said I/O electrode pads and said signal lines as mentioned above. Moreover, by implementation of the surface acoustic wave filter which has the magnitude of attenuation outside high bandwidth, reduction of the components mark of mobile communication equipment is possible, and it contributes to the miniaturization of a device, and low cost-ization.

[Translation done.]